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**Wookey et al.**

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(54) **METHODS AND SYSTEMS FOR PREVENTING A LOCAL DISPLAY DEVICE FROM DISPLAYING DATA GENERATED BY A REMOTE COMPUTING DEVICE**

(58) **Field of Classification Search**  
CPC . G06F 3/1423; G06F 3/1454; G09G 2358/00; H04L 67/36; H04L 67/42; H04L 67/125  
See application file for complete search history.

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(51) **Int. Cl.**

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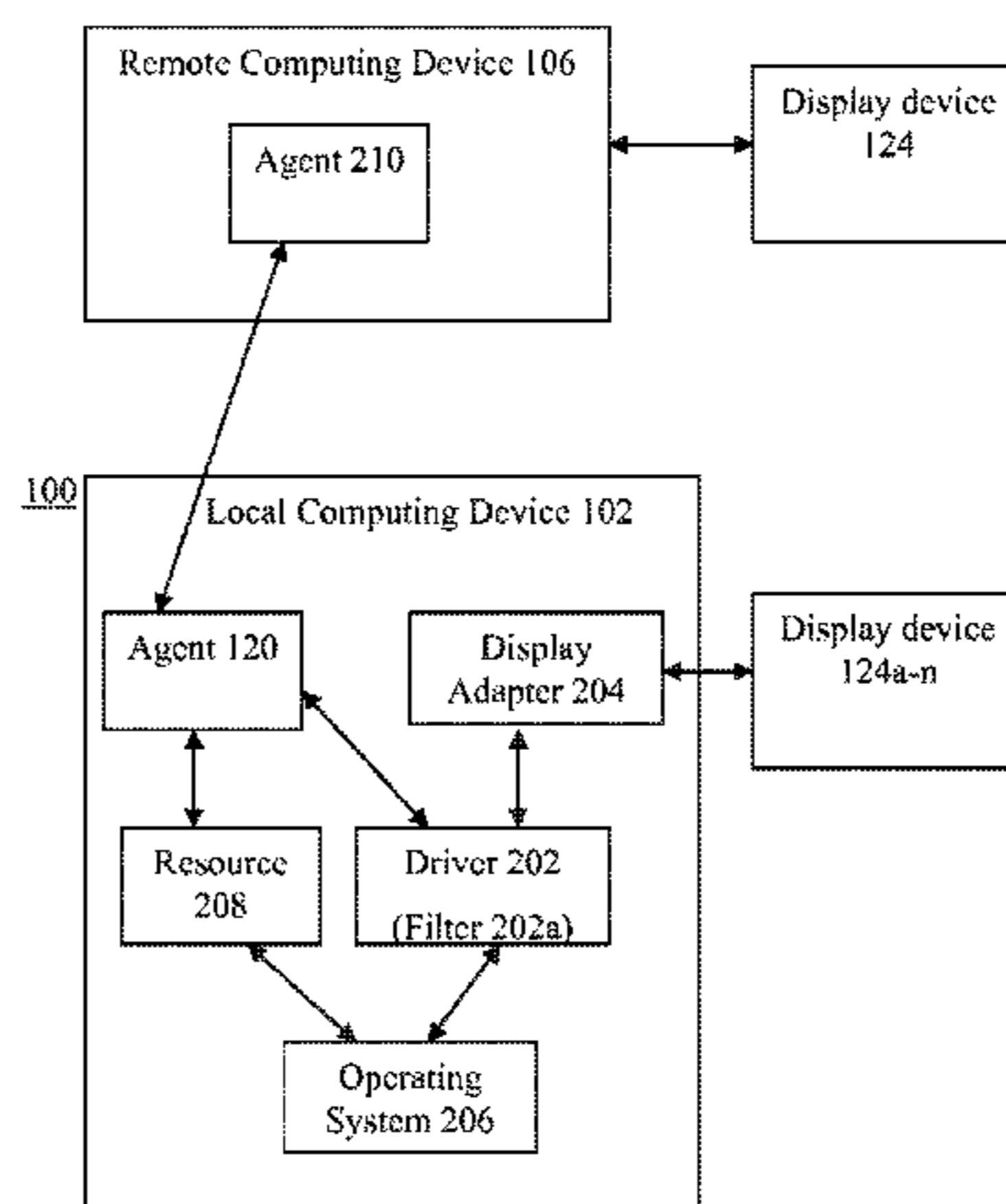
(52) **U.S. Cl.**

CPC ..... **H04L 67/42** (2013.01); **G06F 3/1454** (2013.01); **H04L 67/36** (2013.01); **G06F 3/1423** (2013.01); **G09G 2358/00** (2013.01); **H04L 67/125** (2013.01)

(57) **ABSTRACT**

A method and system for preventing a local display device from, displaying data generated by a remote computing device is described. The system includes a local agent for facilitating a remote session; an operating system generating a request to enable a display device controlled by a display adapter; and a filter executing in a driver and in communication with the local agent, the filter intercepting the request generated by the operating system. The filter transmits the request to the local agent when a remote user is active or to the display adapter when the remote user is inactive. The filter will transmits a signal to the operating system that the display adapter has enabled the display device when the filter transmits the request to at least one of the local agent and the display adapter.

**18 Claims, 5 Drawing Sheets**



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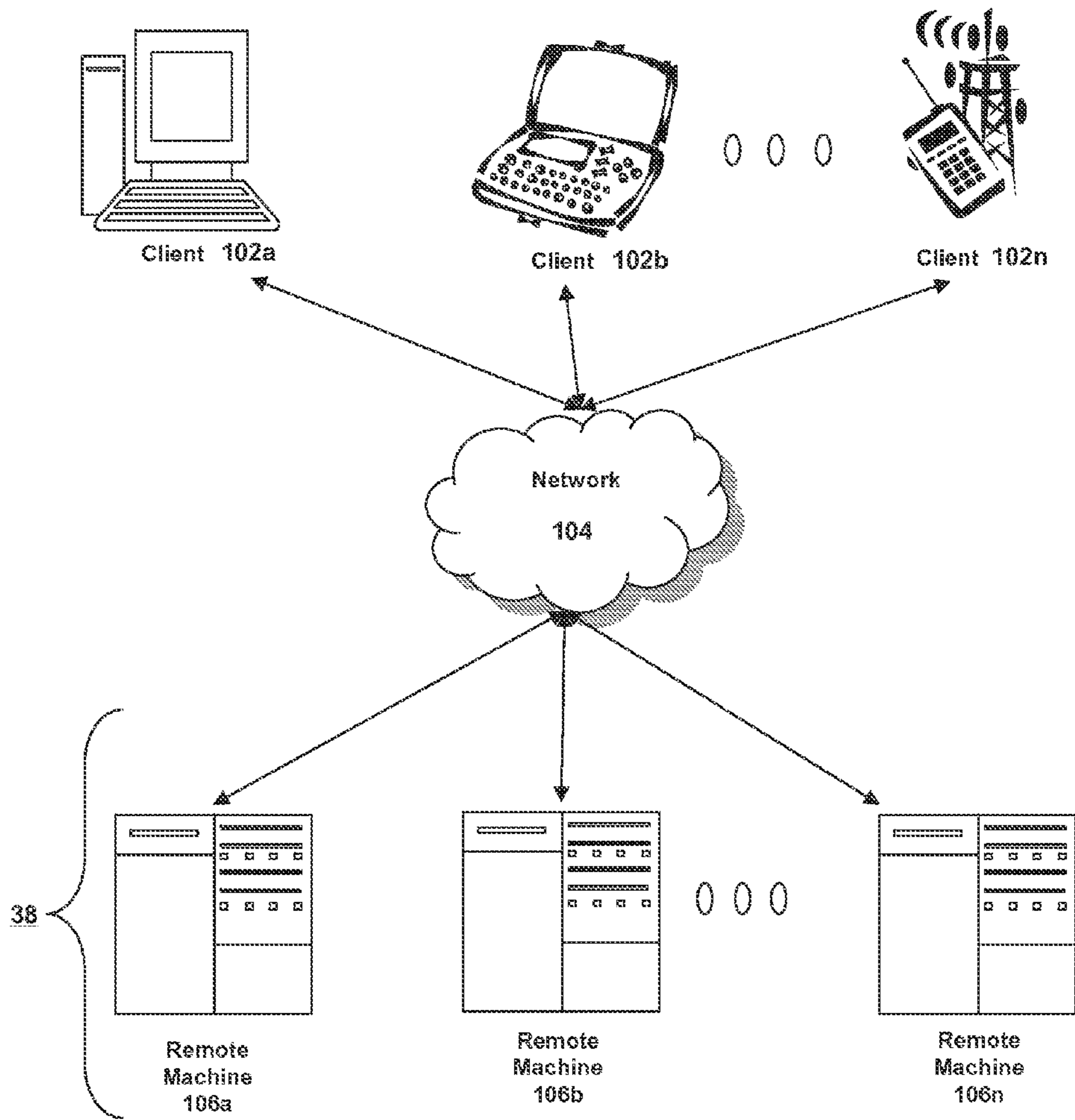
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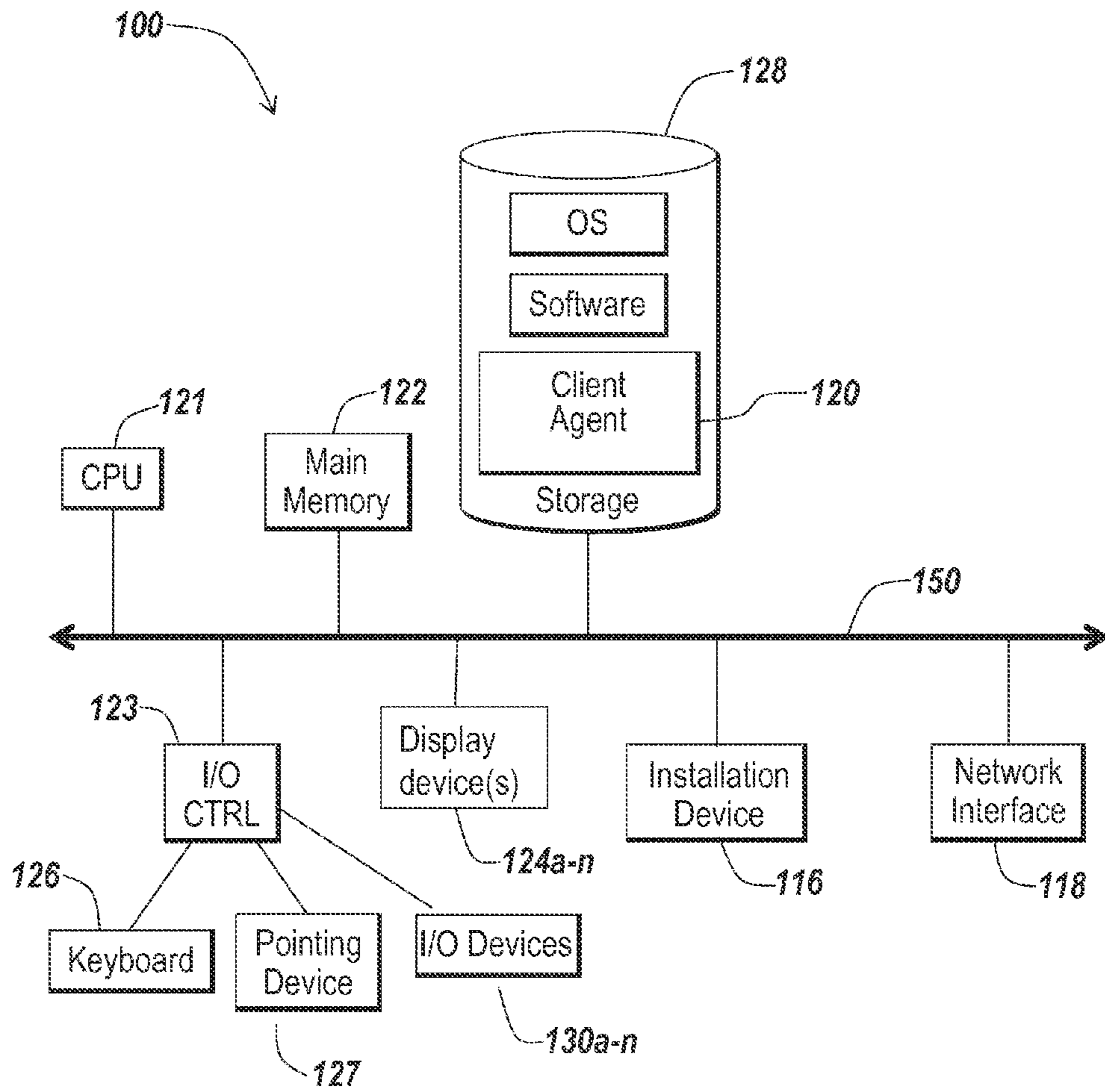
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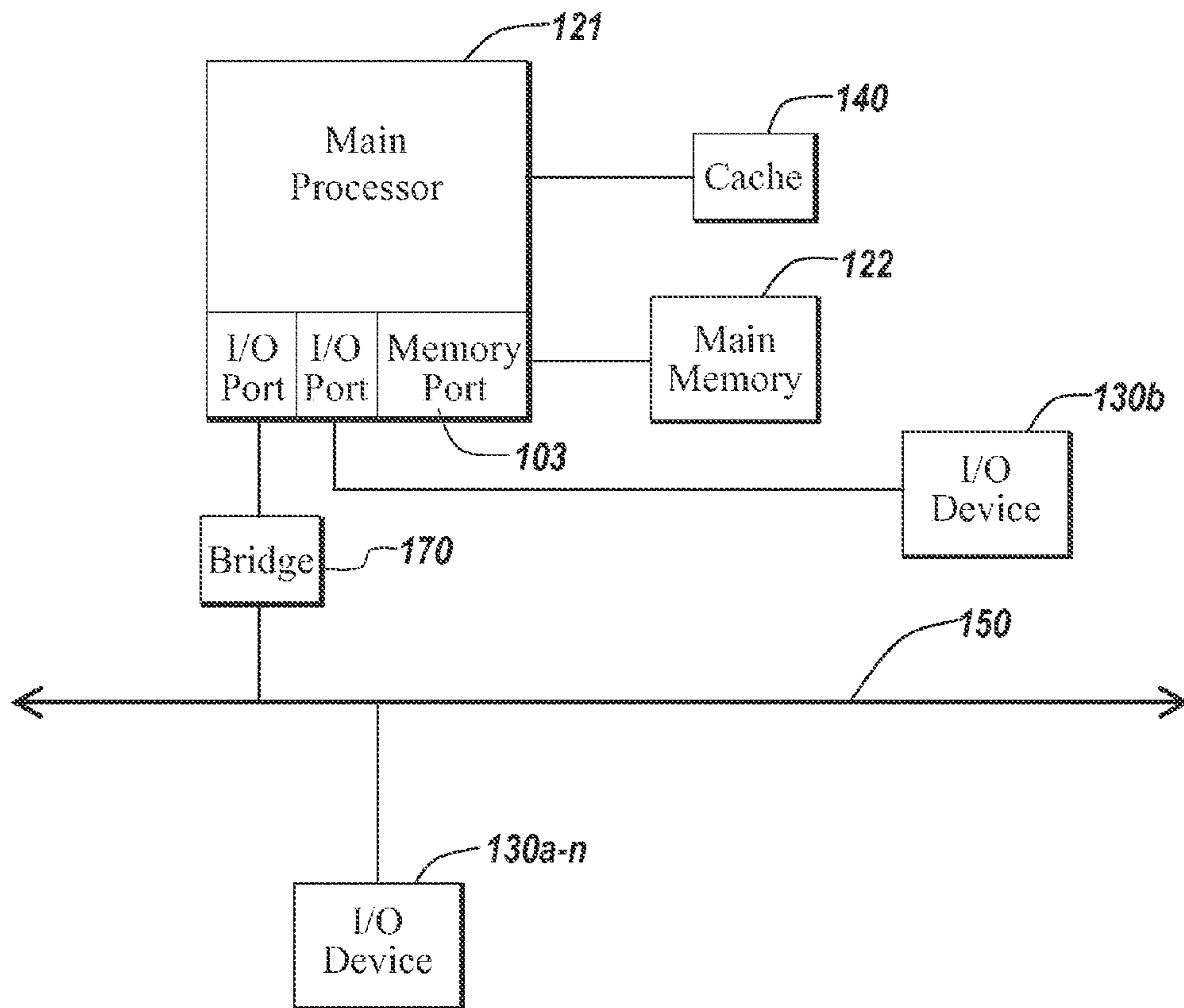
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*Fig. 1A*

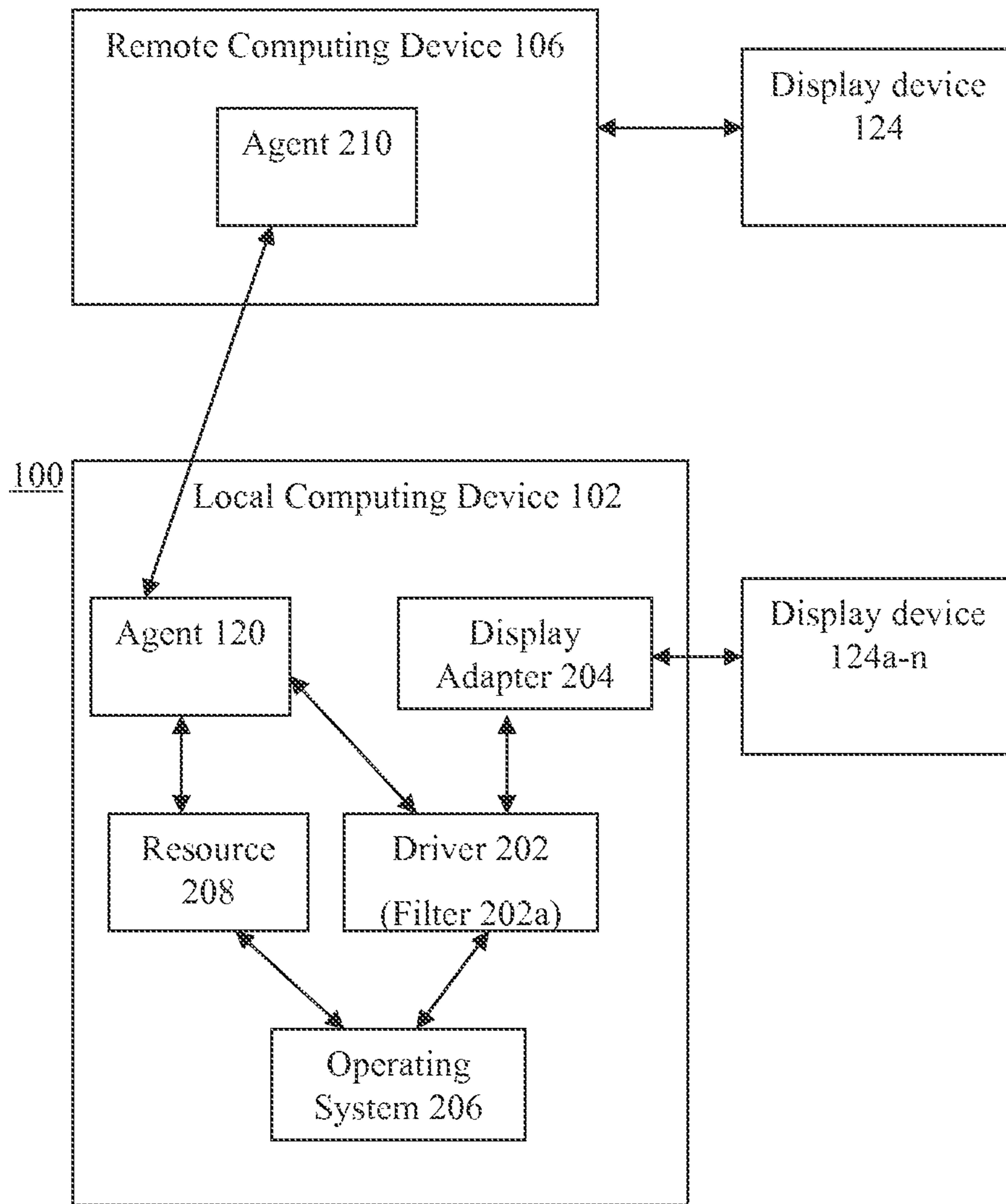


*Fig. 1B*

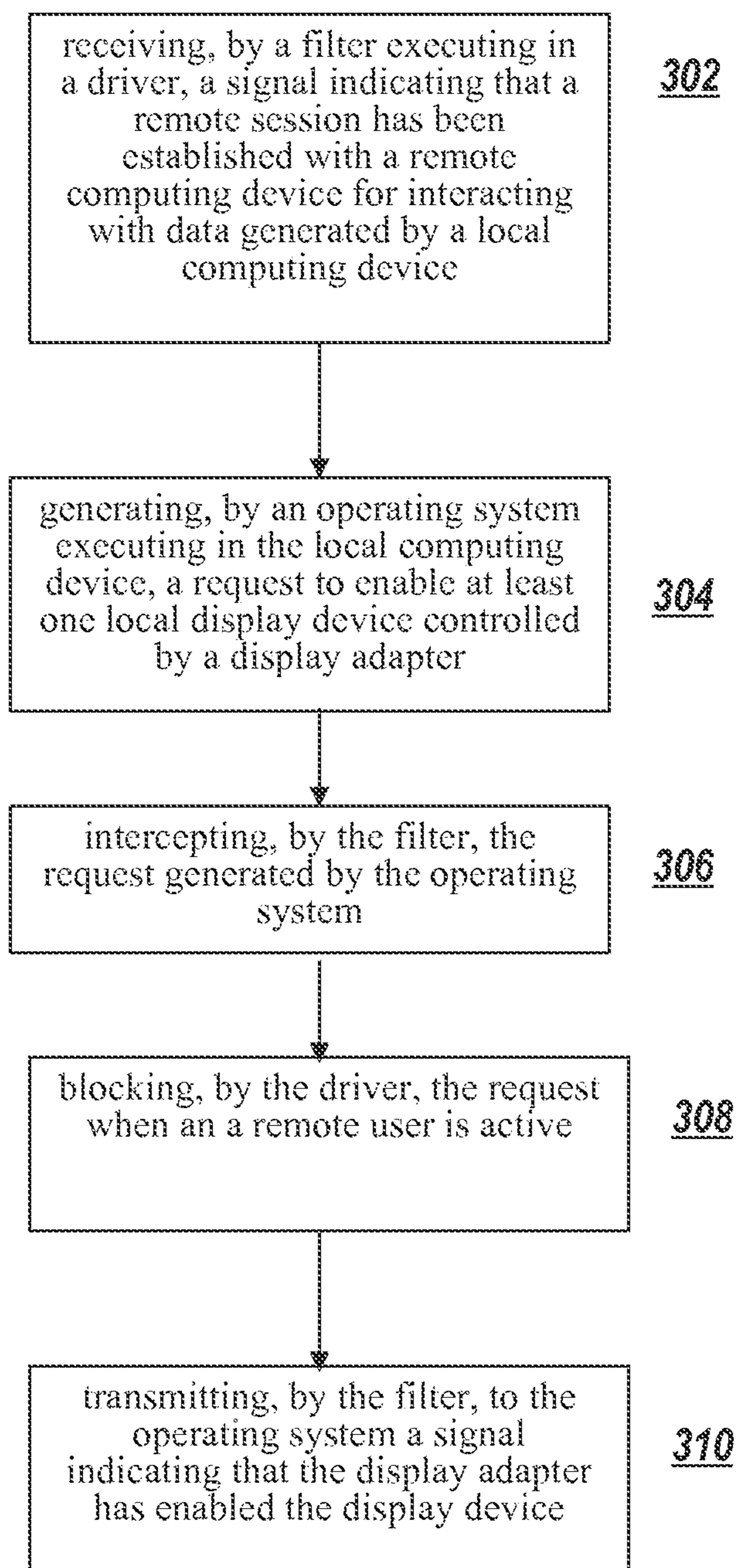


*Fig. 1C*





*Fig. 2*

*Fig. 3*



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**METHODS AND SYSTEMS FOR  
PREVENTING A LOCAL DISPLAY DEVICE  
FROM DISPLAYING DATA GENERATED BY  
A REMOTE COMPUTING DEVICE**

CROSS-REFERENCE TO RELATED PATENT  
APPLICATIONS

This application is a continuation of co-pending U.S. application Ser. No. 12/614,931, filed on Nov. 9, 2009, which claims priority to U.S. Provisional Application No. 61/172,405 filed on Apr. 24, 2009, the entire contents of which is incorporated herein by reference.

FIELD OF THE INVENTION

The present disclosure relates to methods and systems for managing display of data. In particular, the present disclosure relates to methods and systems for preventing a local display device from displaying data generated by a remote computing device.

BACKGROUND OF THE INVENTION

Remoting the desktops of ordinary workstations includes enabling a user to operate a first computing device from a second computing device over the Internet. Examples include remote control software services, such as GoToMyPC produced by Citrix System Inc. Remoting desktops present various problems related to security and information disclosure. In some cases there are certain limitations, which require "screen scraping" of the workstation desktop.

In other cases, the workstation desktop must be enabled and visible so that certain technologies function correctly. For example, GoToMyFC must work with an enabled display. However, one problem with the workstation display being enabled is that anyone local to the workstation, can view what the remote user is doing by simply looking at the local display screen.

There have been various attempts to provide a solution to this issue. For example, in some conventional systems, a full-screen overlay is used to hide the contents of the local workstation desktop when the desktop is being remoted. However, there are limitations with screen overlays. For example, screen overlays can only be used with, one application at a time. In particular, some media player applications (e.g. DVD players), generate full-screen overlays displaying data and do not typically permit a second overlay to be displayed above the generated full-screen overlay. Thus, if a DVD player or other media, player has already created an overlay then, a new overlay cannot be created, leaving the local display visible. GoToMyPC, for example, warns the remote user if it is unable to blank the local monitor because the overlay creating has failed.

A full-screen overlay is also inadequate when the local workstation has a plurality display devices (e.g. monitors). An overlay can only be created on one of the plurality of monitors, leaving the rest of the monitors exposed.

In other systems, when a local user presses a combination of keys, such as, Ctl-Alt-Del to activate the local desktop, the overlay will disappear, allowing display of the remote data. In addition, although many remote control software services prevent local input when a remote user is attached to the local computing device (i.e. the local user is unable to interact with the local computing device), a local user can observe everything that the remote user is doing via the local display. Moreover, most remote control software services will not

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re-establish the overlay, leaving the local computing device vulnerable to anyone wishing to view the desktop.

Thus, conventional systems for disabling local workstation displays do not provide reliable functionality for blocking the display of data generated remotely. Nor do such conventional systems provide for preventing typical overlays from interfering with the execution of authorized applications on the machine.

SUMMARY OF THE INVENTION

The present disclosure is directed to a method and system for preventing a local display device from displaying data generated by a remote computing device. In one embodiment, the disclosure relates to power management for powering up and down the locally attached monitors when a remote user is connected to a local computing device. Many operating systems include a component responsible for sending a message to the display adapter infrastructure to power up when an input device (e.g. a mouse or a keyboard) is present. In the presently disclosed system, the message that indicates that the local display should power up are filtered for preventing the request from being relayed to the local display adapter when a remote user is currently active. Once the remote user has disconnected, the filter sends another message to the local display indicating that it can power up again. The local user is therefore prevented from observing what the remote user is doing on the local desktop. Even attempting to plug in a new monitor will still fail since the display adapter has been told not to power on.

Therefore, the presently described system and method allow for secure local desktops, including those with multiple monitors, whenever one or more desktop remoting technologies is active. In one particular embodiment of the presently disclosed system, and method, the display of a local computing device is blanked when a remote computing device generates data associated with data generated by the local computing device. Moreover, the present system and method allows for the use of secure screen blanking in conjunction with graphically intense application.

In one embodiment, a computing device is described. The computing device includes a local agent connected to a remote agent for facilitating a remote session with a remote user; an operating system generating a request to enable a display device controlled by a display adapter; and a filter executing in a driver and in communication with the local agent, the filter intercepting the request generated by the operating system. The filter will transmit the request to the local agent when a remote user is active, and to the display adapter when said remote user is inactive. The filter will then transmit a signal to the operating system that the display adapter has enabled the display device when the filter transmits the request to at least one of the local agent and the display adapter. In one embodiment, the filter transmits the request to the display adapter when the remote session is ended. In another embodiment, the filter transmits the request to the display adapter when the remote user is inactive. In yet another embodiment, the filter transmits the request to the display adapter when no remote session is facilitated. In one particular embodiment, the local agent activates the filter when a remote session is facilitated.

A method of filtering a request to display data generated by a remote computing device is also described. The method includes receiving, by a filter executing in a driver, a signal indicating that a remote session has been established with a remote computing device for interacting with data generated by a local computing device; generating, by an operating



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system executing in the local computing device, a request to enable at least one local display device controlled by a display adapter; intercepting, by the filter, the request generated by the operating system; blocking, by the driver, the request when an a remote user is active; and transmitting, by the filter, to the operating system a signal, indicating that tire display adapter has enabled the display device. The method further includes transmitting, by the filter, the request to enable the at least one local display device to the display adapter when the remote user is inactive. In another embodiment, the method further includes transmitting, by the filter, the request to enable the at least one local display device to the display adapter when the remote session terminates. In one particular embodiment, the step of receiving Includes activating, by a local agent executing in the local computing device and associated with the remote computing device, the filter when the remote session is established, where the local agent facilitates the remote session. In yet another embodiment, the filter transmits the request to enable the at least one display device to the local agent when the remote user active. The driver is a locally executed driver associated with the operating system and the display adapter. In one embodiment the request to enable is adapted for instructing the display adapter to power up the at least one display device. In another embodiment, the request to enable is generated by at least one input device of the local computing device.

A method for preventing a local computing device from displaying data generated by a remote computing device is also described. The method includes receiving, by the driver, a signal that a remote session has been established with the local computing device; intercepting, by a driver executing in a local computing device, a request generated by an operating system to enable at least one display device associated with the local computing device; transmitting, by the driver, the request generated by the operating system to a local agent, when a remote user is active; and transmitting, by the driver, the request generated by the operating system to a display adapter when a remote user is inactive, where the display adapter is adapted activating the at least one display device. The method further includes transmitting, by the driver, to the operating system a signal indicating that the display adapter has enabled the at least one display device. In addition, the method further includes activating, by said local agent, a filter executing in the driver for detecting the remote user. In one particular embodiment, the method further includes intercepting, by the driver, a power request to the display adapter instructing said display adapter to power up the at least one display device, said power request generated by the operating system; and preventing, by the driver, the power request from reaching the display adapter when a remote user interacts with the local computing device. In this particular embodiment, the power request is generated by at least one input device.

The method further includes intercepting, by a second driver, a request from an application executing on the computing device, addressed to the display adapter, for a status of the display device; determining, by the second driver, that the display device is disabled and that the remote user is interacting with a remote display of the locally generated data; and transmitting, by the second driver, to the application, a response to the intercepted request indicating that the display device is enabled. Moreover, the method further includes intercepting, by the driver, a power request to the display adapter instructing said display adapter to power up the at least one display device, said power request generated by the operating system; and preventing, by the driver, the power

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request from teaching the display adapter when a remote user interacts with the local computing device.

Other features of the presently disclosed methods and systems for preventing a local display device from displaying data generated by a remote computing device will become apparent from the following detailed description taken in conjunction with the accompanying drawing, which illustrate, by way of example, the presently disclosed method and system.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, aspects, features, and advantages of the disclosure will become more apparent and better understood by referring to the following description taken in conjunction, with the accompanying drawings, in which:

FIG. 1A is a block diagram depicting an embodiment of a network environment comprising client machines in communication with remote machines;

FIGS. 1B and 1C are block diagrams depicting embodiments of computers useful in connection with the methods and systems described herein;

FIG. 2 is a block diagram, depicting one embodiment of a system for preventing a local display device from displaying data generated by a remote computing device according to one embodiment of the presently described system; and

FIG. 3 is a flow diagram depicting one embodiment of a method for preventing a local computing device from displaying data generated by a remote computing device, according to one embodiment of the presently described method.

#### DETAILED DESCRIPTION

Referring now to FIG. 1A, an embodiment of a network environment is depicted. In brief overview, the network environment comprises one or more clients **102a-102n** (also generally referred to as local machine(s) **102**, client(s) **102**, client node(s) **102**, client machine(s) **102**, client computer(s) **102**, client device(s) **102**, endpoint(s) **102**, or endpoint node(s) **102**) in communication with one or more servers **106a-106n** (also generally referred to as server(s) **106** or remote machine(s) **106**) via one or more networks **104**. In some embodiments, a client **102** has the capacity to function as both a client node seeking access to resources provided by a server and as a server providing access to hosted resources for other clients **102a-102n**.

Although FIG. 1A shows a network **104** between the clients **102** and the servers **106**, the clients **102** and the servers **106** may fee on the same network **104**. The network **104** can be a local-area, network (LAN), such as a company intranet, a metropolitan area network (MAN), or a wide area network (WAN), such as the internet or the World Wide Web. In some embodiments, there are multiple networks **104** between the clients **102** and the servers **106**. In one of these embodiments, a network **104'** (not shown) may be a private network and a network **104** may be a public network. In another of these embodiments, a network **104** may be a private network and a network **104'** a public network. In still another embodiment, networks **104** and **104'** may both be private networks.

The network **104** may be any type and/or form of network and may include any of the following: a point to point network, a broadcast network, a wide area network, a local area network, a telecommunications network, a data communication network, a computer network, an ATM (Asynchronous Transfer Mode) network, a SONET (Synchronous Optical



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Network) network, a SDH (Synchronous Digital Hierarchy) network, a wireless network and a wireline network. In some embodiments, the network **104** may comprise a wireless link, such as an infrared channel or satellite band. The topology of the network **104** may be a bus, star, or ring network topology. The network **104** may be of any such network topology as known to those ordinarily skilled in the art capable of supporting the operations described herein. The network may comprise mobile telephone networks utilizing any protocol or protocols used to communicate among mobile devices, including AMPS, TPMA, CDMA, GSM, GPRS or UMTS. In some embodiments, different types of data may be transmitted via different protocols. In other embodiments, the same types of data may be transmitted via different protocols.

In some embodiments, the system may include multiple, logically grouped servers **106**. In one of these embodiments, the logical group of servers may be referred to as a server farm **38**. In another of these embodiments, the servers **106** may be geographically dispersed. In other embodiments, a server farm **38** may be administered as a single entity. In still other embodiments, the server farm **38** comprises a plurality of server farms **38**. The servers **106** within each server farm **38** can be heterogeneous—one or more of the servers **106** can operate according to one type of operating system, platform (e.g., WINDOWS NT, manufactured by Microsoft Corp. of Redmond, Wash.), while one or more of the other servers **106** can operate on according to another type of operating system platform, (e.g., Unix or Linux).

The servers **106** of each server farm **38** do not need to be physically proximate to another server **106** in the same server farm **38**. Thus, the group of servers **106** logically grouped as a server farm **38** may be interconnected using a wide-area network (WAN) connection or a metropolitan-area network (MAN) connection. For example, a server farm **38** may include servers **106** physically located in different continents or different regions of a continent, country, state, city, campus, or room. Data transmission speeds between servers **106** in the server farm **38** can be increased if the servers **106** are connected using a local-area network (LAN) connection or some form of direct connection.

Server **106** may be a file server, application, server, web server, proxy server, appliance, network appliance, gateway, application gateway, gateway server, virtualization server, deployment server, SSL VPN server, or firewall. In some embodiments, a server **106** provides a remote authentication dial-in user service, and is referred to as a RADIUS server. In other embodiments, a server **106** may have the capacity to function as either an application, server or as a master application server. In still other embodiments, a server **106** is a blade server. In yet other embodiments, a server **106** executes a virtual machine providing, to a user or client computer **102**, access to a computing environment.

In one embodiment, a server **106** may include an Active Directory. The server **106** may be an application acceleration appliance. For embodiments in which the server **106** is an application acceleration appliance, the server **106** may provide functionality including firewall functionality, application firewall functionality, or load balancing functionality. In some embodiments, the server **106** comprises an appliance such as one of the line of appliances manufactured by the Citrix Application Networking Group, of San Jose, Calif., or Silver Peak Systems, Inc., of Mountain View, Calif., or of Riverbed Technology, Inc., of San Francisco, Calif., or of F5 Networks, Inc., of Seattle, Wash., or of Juniper Networks, Inc., of Sunnyvale, Calif.

In some embodiments, a server **106** executes an application on behalf of a user of a client **102**. In other embodiments, a

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server **106** executes a virtual machine, which provides an execution session within which, applications execute on behalf of a user or a client **102**. In one of these embodiments, the execution session is a hosted desktop session. In another of these embodiments, the execution session, provides access to a computing environment, which may comprise one or more of: art application, a plurality of applications, a desktop application, and a desktop session in which one or more application may execute.

In some embodiments, a client **102** communicates with a server **106**. In one embodiment, the client **102** communicates directly with one of the servers **106** in a server farm **38**. In another embodiment, the client **102** executes a program neighborhood application to communicate with a server **106** in a server farm **38**. In still another embodiment, the server **106** provides the functionality of a master node. In some embodiments, the client **102** communicates with the server **106** in the server farm **38** through a network **104**. Over the network **104**, the client **102** can, for example, request execution of various applications hosted by the servers **106a-106n** in the server farm **38** and receive output of the results of the application execution for display. In some embodiments, only the master node provides the functionality required to identify and provide address information associated with a server **106b** hosting a requested application.

In one embodiment, the server **106** provides the functionality of a web server. In another embodiment, the server **106a** receives requests from the client **102**, forwards the requests to a second server **106b** and responds to the request by the client **102** with a response to the request from the server **106b**. In still another embodiment, the server **106** acquires an enumeration of applications available to the client **102** and address information, associated with a server **106'** hosting an application identified by the enumeration of applications. In yet another embodiment, the server **106** presents the response to the request to the client **102** using a web interface. In one embodiment, the client **102** communicates directly with the server **106** to access the identified application. In another embodiment, the client **102** receives output data, such as display data, generated by an execution of the identified application on the server **106**.

In some embodiments, the server **106** or a server farm **38** may be running one or more applications, such as an application providing a thin-client computing or remote display presentation application. In one embodiment, the server **106** or server farm **38** executes as an application any portion of the CITRIX ACCESS SUITE by Citrix Systems, Inc., such as the METAFRAME or CITRIX PRESENTATION SERVER and/or any of the MICROSOFT WINDOWS Terminal Services manufactured by the Microsoft Corporation. In another embodiment, the application is an ICA client developed by Citrix Systems, Inc. of Fort Lauderdale, Fla. In still another embodiment, the server **106** may run an application, which, for example, may be an application server providing email services such as MICROSOFT EXCHANGE manufactured by the Microsoft Corporation, of Redmond, Wash., a web or Internet server, or a desktop sharing server, or a collaboration server. In yet another embodiment, any of the applications may comprise any type of hosted service or products, such as GOTOMEETING provided by Citrix Online Division, Inc. of Santa Barbara, Calif., WEBEX provided by WebEx, Inc. of Santa Clara, Calif., or Microsoft Office LIVE MEETING provided by Microsoft Corporation of Redmond, Wash.

A client **102** may execute, operate or otherwise provide an application, which can be any type and/or form of software, program, or executable instructions such as any type and/or form of web browser, web-based client, client-server appli-



cation, a thin-client computing client, an ActiveX control, or a Java applet, or any other type and/or form of executable instructions capable of executing on client **102**. In some embodiments, the application may be a server-based or a remote-based, application executed on behalf of the client **102** on a server **106**. In one embodiment the server **106** may display output to the client **102** using any thin-client or remote-display protocol, such as the Independent Computing Architecture (ICA) protocol manufactured by Citrix Systems, Inc. of Ft. Lauderdale, Fla. or the Remote Desktop Protocol (RDP) manufactured by the Microsoft Corporation of Redmond, Wash. The application can use any type of protocol and it can be, for example, an HTTP client, an FTP client, an Oscar client, or a Telnet client. In other embodiments, the application comprises any type of software related to voice over internet protocol (VoIP) communications, such as a soft IP telephone. In further embodiments, the application comprises any application related to real-time data communications, such as applications for streaming video and/or audio.

The client **102** and server **106** may be deployed: as and/or executed on any type and form of computing device, such as a computer, network device or appliance capable of communicating on any type and form of network and performing the operations described herein. FIGS. **1B** and **1C** depict block diagrams of a computing device **100** useful for practicing an embodiment of the client **102** or a server **106**. As shown in FIGS. **1B** and **1C**, each computing device **100** includes a central processing unit **121**, and a main memory unit **122**. As shown in FIG. **1B**, a computing device **100** may include a storage device **128**, an installation device **116**, a network interface **118**, an I/O controller **123**, display devices **124a-n**, a keyboard **126** and a pointing device **127**, such as a mouse. The storage device **128** may include, without limitation, an operating system, software, and a client agent **120**. As shown in FIG. **1C**, each computing device **100** may also include additional optional elements, such as a memory port **103**, a bridge **170**, one or more input/output devices **130a-130n** (generally referred to using reference numeral **130**), and a cache memory **140** in communication with the central processing unit **121**.

The central processing unit **121** is any logic circuitry that responds to and processes instructions fetched from the main memory unit **122**. In many embodiments, the central processing unit **121** is provided by a microprocessor unit, such as: those manufactured by Intel Corporation of Mountain View, Calif.; those manufactured by Motorola Corporation of Schaumburg, Ill.; those manufactured by Transmeta Corporation of Santa Clara, Calif.; the RS/6000 processor, those manufactured by International Business Machines of White Plains, N.Y.; or those manufactured by Advanced Micro Devices of Sunnyvale, Calif. The computing device **100** may be based on any of these processors, or any other processor capable of operating as described herein.

Main memory unit **122** may be one or more memory chips capable of storing data and allowing any storage location to be directly accessed by the microprocessor **121**, such as Static random access memory (SRAM), Burst SRAM or Synchronous Burst SRAM (BSRAM), Dynamic random access memory (DRAM), Fast Page Mode DRAM (FPM DRAM), Enhanced DRAM (EDRAM), Extended Data Output RAM (EDO RAM), Extended Data Output DRAM (EDO DRAM), Burst Extended Data Output DRAM (REDO DRAM), Enhanced DRAM (EDRAM), synchronous DRAM (SDRAM), JEDEC SRAM, PC100 SDRAM, Double Data Rate SDRAM (DDR SDRAM), Enhanced SDRAM; (ESDRAM), SyncLink DRAM (SLDRAM), Direct Rambus DRAM (DRDRAM), or

Ferroelectric RAM (FRAM). The main memory **122** may be based on any of the above described memory chips, or any other available memory chips capable of operating as described herein. In the embodiment shown in FIG. **1B**, the processor **121** communicates with main memory **122** via a system bus **150** (described in more detail below). FIG. **1C** depicts an embodiment of a computing device **100** in which the processor communicates directly with main memory **122** via a memory port **103**. For example, in FIG. **1C** the main memory **122** may be DRDRAM.

FIG. **1C** depicts an embodiment in which the main processor **121** communicates directly with cache memory **140** via a secondary bus, sometimes referred to as a backside bus. In other embodiments, the main processor **121** communicates with cache memory **140** using the system bus **150**. Cache memory **140** typically has a faster response time than main memory **122** and is typically provided by SRAM, BSRAM, or EDRAM. In the embodiment shown in FIG. **1C**, the processor **121** communicates with various I/O devices **130** via a local system bus **150**. Various buses may be used to connect the central processing unit **121** to any of the I/O devices **130**, including a VESA VL bus, an ISA bus, an EISA bus, a MicroChannel Architecture (MCA) bus, a PCI bus, a PCI-X bus, a PCI-Express bus, or a NuBus. For embodiments in which the I/O device is a video display **124**, the processor **121** may use an Advanced Graphics Port (AGP) to communicate with the display **124**. FIG. **1C** depicts an embodiment of a computer **100** in which the main processor **121** communicates directly with I/O device **130b** via HYPERTRANSPORT, RAPIDIO, or INFINIBAND communications technology. FIG. **1C** also depicts an embodiment in which local buses and direct communication are mixed: the processor **121** communicates with I/O device **130a** using a local interconnect bus while communicating with I/O device **130b** directly.

A wide variety of I/O devices **130a-130n** may be present in the computing device **100**. Input devices include keyboards, mice, trackpads, trackballs, microphones, and drawing tablets. Output devices include video displays, speakers, inkjet printers, laser printers, and dye-sublimation printers. The I/O devices may be controlled by an I/O controller **123** as shown in FIG. **1B**. The I/O controller may control one or more I/O devices such as a keyboard **126** and a pointing device **127**, e.g., a mouse or optical pen. Furthermore, an I/O device may also provide storage and/or an installation medium **116** for the computing device **100**. In still other embodiments, the computing device **100** may provide USB connections (not shown) to receive handheld USB storage devices such as the USB Flash Drive line of devices manufactured by Twintech Industry, Inc. of Los Alamitos, Calif.

Referring again to FIG. **1B**, the computing device **100** may support any suitable installation device **116**, such as a floppy disk drive for receiving floppy disks such as 3.5-inch, 5.25-inch disks or ZIP disks, a CD-ROM drive, a CD-R/RW drive, a DVD-ROM drive, tape drives of various formats, USB device, hard-drive or any other device suitable for installing software and programs. The computing device **100** may further comprise a storage device, such as one or more hard disk drives or redundant arrays of independent disks, for storing an operating system and other related software, and for storing application software programs such as any program, related to the client agent **120**. Optionally, any of the installation devices **116** could also be used as the storage device. Additionally, the operating system and the software can be run from a bootable medium, for example, a bootable CD, such as KNOPPIX, a bootable CD for GNU/Linux that is available as a GNU/Linux distribution from knoppix.net.



Furthermore, the computing device **100** may include a network interface **118** to interface to tire network **104** through a variety of connections including, but not limited to, standard, telephone lines, LAN or WAN links (e.g., 802.11, T1, T3, 56 kb, X.25, SNA, DECNET), broadband connections (e.g., ISDN, Frame Relay, ATM, Gigabit Ethernet, Ethernet-over-SONET), wireless connections, or some combination of any or ail of the above. Connections can be established using a variety of communication protocols (e.g., TCP/IP, IPX, SPX, NetBIOS, Ethernet, ARC-NET, SONET, SDH, Fiber Distributed. Data Interface (FDDI), RS232, IEEE 802.11, IEEE 802.11a, IEEE 802.11.b, IEEE 802.11g, CDMA, GSM, WiMax and direct asynchronous connections). In one embodiment, the computing device **100** communicates with other computing devices **100'** via any type and/or form of gateway or tunneling protocol such as Secure Socket Layer (SSL) or Transport Layer Security (TLS), or the Citrix Gateway Protocol manufactured by Citrix Systems, Inc. of Ft. Lauderdale, Fla. The network interface **118** may comprise a built-in network adapter, network interface card, PCMCIA network card, card bus network adapter, wireless network adapter, USE network adapter, modem or any other device suitable for interfacing the computing device **100** to any type of network capable of communication and performing the operations described herein.

In some embodiments, the computing device **100** may comprise or be connected to multiple display devices **124a-124n**, which each may be of the same or different type and/or form. As such, any of the I/O devices **130a-130n** and/or the I/O controller **123** may comprise any type and/or form of suitable hardware, software, or combination of hardware and software to support, enable or provide for the connection and use of multiple display devices **124a-124n** by the computing device **100**. For example, the computing device **100** may include any type and/or form of video adapter, video card, driver, and/or library to interface, communicate, connect or otherwise use the display devices **124a-124n**. In one embodiment a video adapter may comprise multiple connectors to interface to multiple display devices **124a-124n**. In other embodiments. the computing device **100** may include multiple video adapters, with each video adapter connected to one or more of the display devices **124a-124n**. In some embodiments, any portion of the operating system of the computing device **100** may be configured for using multiple displays **124a-124n**. In other embodiments, one or more of the display devices **124a-124n** may be provided by one or more other computing devices, such as computing devices **100a** and **100b** connected to the computing device **100**, for example, via a network. These embodiments may include any type of software designed and constructed to use another computer's display device as a second display device **124a** for the computing device **100**. One ordinarily skilled in the art will recognise and appreciate the various ways and embodiments that a computing device **100** may be configured to have multiple display devices **124a-124n**.

In further embodiments, an I/O device **130** may be a bridge between the system bus **150** and an external communication bus, such as a USB bus, an Apple Desktop Bus, an RS-232 serial connection, a SCSI bus, a FireWire bus, a FireWire 800 bus, an Ethernet bus, an AppleTalk bus, a Gigabit Ethernet bus, an Asynchronous Transfer Mode bus, a HIPPI bus, a Super HIPPI bus, a SerialPlus bus, a SCI/LAMP bus, a Fibre-Channel bus, or a Serial Attached small computer system interface bus.

A computing device **100** of the sort depicted in FIGS. **1B** and **1C** typically operates under the control of operating systems, which control scheduling of tasks and access to system

resources. The computing device **100** can be running any operating system such as any of the versions of the MICROSOFT WINDOWS operating systems, the different releases of the Unix and Linux operating systems, any version of the MAC OS for Macintosh computers, any embedded operating system, any real-time operating system, any open source operating system, any proprietary operating system, any operating systems for mobile computing devices, or any other operating system capable of running on the computing device and performing the operations described herein. Typical operating systems include, but are not limited to: WINDOWS 3.x, WINDOWS 95, WINDOWS 98, WINDOWS 2000, WINDOWS NT 3.51, WINDOWS NT 4.0, WINDOWS CE, WINDOWS XP; and WINDOWS VISTA, all of which are manufactured by Microsoft Corporation, of Redmond, Wash.; MAC OS, manufactured by Apple Computer of Cupertino, Calif.; OS/2, manufactured by International Business Machines of Armonk, N.Y.; and Linux, a freely-available operating system distributed by Caldera Corp. of Salt Lake City, Utah, or any type and/or form of a Unix operating system, among others.

The computer system **100** can be any workstation, desktop computer, laptop or notebook computer, server, handheld computer, mobile telephone or other portable telecommunication device, media playing device, a gaming system, mobile computing device, or any other type and/or form of computing, telecommunications or media device that is capable of communication and that has sufficient processor power and memory capacity to perform the operations described herein. For example, the computer system **100** may comprise a device of the IPOD family of devices manufactured by Apple Computer of Cupertino, Calif., a PLAYSTATION 2, PLAYSTATION 3, or PERSONAL PLAYSTATION PORTABLE (PSP) device manufactured by the Sony Corporation of Tokyo, Japan, a NINTENDO DS, NINTENDO GAMEBOY, NINTENDO GAMEBOY ADVANCED or NINTENDO REVOLUTION device manufactured by Nintendo Co., Ltd., of Kyoto, Japan, or an XBOX or XBOX 360 device manufactured by the Microsoft Corporation of Redmond, Wash.

In some embodiments, the computing device **100** may have different processors, operating systems, and input devices consistent with the device. For example, in one embodiment, the computing device **100** is a TREO 180, 270, 600, 650, 680, 700p, 700w/wx, 750, 755p, 800w, Centro, or Pro smart phone manufactured by Palm, Inc. In some of these embodiments, the TREO smart phone is operated under the control of the PalmOS operating system and includes a stylus input device as well as a five-way navigator device.

In other embodiments the computing: device **100** is a mobile device, such as a JAVA-enabled cellular telephone or personal digital assistant (PDA), such as the i55sr, i58sr, i85s, i88s, i90c, i95cl, i335, i365, i570, i576, i580, i615, i760, i836, i850, i870, i880, i920, i930, ic502, ic602, ic902, i776 or the im1100, all of which are manufactured by Motorola Corp. of Schaumburg, Ill., the 6035 or the 7135, manufactured, by Kyocera of Kyoto, Japan, or the i300 or i330, manufactured by Samsung Electronics Co., Ltd., of Seoul, Korea. In some embodiments, the computing device **100** is a mobile device manufactured by Nokia of Finland, or by Sony Ericsson Mobile Communications AB of Lund, Sweden.

In still other embodiments, the computing device **100** is a Blackberry handheld or smart phone, such as the devices manufactured by Research In Motion Limited, including the Blackberry 7100 series, 8700 series, 7700 series, 7200 series, the Blackberry 7520, the Blackberry PEARL 8100, the 8700 series, the 8800 series, the Blackberry Storm, Blackberry Bold, Blackberry Curve 8900, and the Blackberry Pearl Flip.



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In yet other embodiments, the computing device **100** is a smart phone, Pocket PC, Pocket PC Phone, or other handheld mobile device supporting Microsoft Windows Mobile Software. Moreover, the computing device **100** can be any workstation, desktop computer, laptop or notebook computer, server, handheld computer, mobile telephone, any other computer, or other form of computing or telecommunications device that is capable of communication and that has sufficient processor power and memory capacity to perform the operations described herein.

In some embodiments, the computing device **100** is a digital audio player. In one of these embodiments, the computing device **100** is a digital audio player such as the Apple IPOD, IPOD Touch, IPOD NANO, and IPOD SHUFFLE lines of devices, manufactured by Apple Computer of Cupertino, Calif. In another of these embodiments, the digital audio player may function as both a portable media player and as a mass storage device. In other embodiments, the computing device **100** is a digital audio player such as the DigitalAudioPlayer Select MP3 players, manufactured by Samsung Electronics America, of Ridgefield Park, N.J., or the Motorola m500 or m25 Digital Audio Players, manufactured by Motorola Inc. of Schaumburg, Ill. In still other embodiments, the computing device **100** is a portable media player, such as the Zen Vision W, the Zen Vision series, the Zen Portable Media Center devices, or the Digital MP3 line of MP3 players, manufactured by Creative Technologies Ltd. In yet other embodiments, the computing device **100** is a portable media player or digital audio player supporting file formats including, but not limited to, MP3, WAV, M4A/AAC, WMA Protected AAC, AIFF, Audible audiobook, Apple Lossless audio file-formats and .mov, .m4v, and .mp4 MPEG-4 (H.264/MPEG-4 AVC) video file formats.

In some embodiments, the computing device **100** comprises a combination of devices, such as a mobile phone combined with a digital audio player or portable media player. In one of these embodiments, the computing device **100** is a Motorola RAZR or Motorola ROKR line of combination digital audio players and mobile phones. In another of these embodiments, the computing device **100** is an iPhone smartphone, manufactured by Apple Computer of Cupertino, Calif.

Referring now to FIG. 2, a block diagram illustrates one embodiment of a system **100** for preventing a local display device from displaying data generated by a remote user during a remote session. In brief overview, system **100** includes a local computing device **102** communicating with a remote computing device in a network environment, as described, hereinabove. The local computing device **106** includes an agent **120** communicating with, an agent **210** of remote computing device **106** for facilitating a remote session. The computing device **106** further includes an operating system **206** executing in local computing device **106** and associated with a plurality of resources **208**. A driver **202** is connected to the operating system **206**, the local agent **120** and to a display adapter **204**. The display adapter is connected at least one display device **124a-n**. In accordance with, the present disclosure, the driver **202** executes on the computing device **106** and intercepts a request, generated by the operating system **206**, to enable the at least one display device **124a-n** associated with the computing device **106**. The driver **202** receives an indication that a remote user is interacting with locally generated data. Accordingly, the driver **202** determines not to transmit the intercepted request to the display adapter **204** thus providing for a more secure remotings.

Referring to FIG. 2, and in greater detail, driver **202** is an executable local driver that may be dynamically loaded. In

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accordance with an embodiment of the present disclosure, the driver **202** is a filter **202a** for intercepting requests to power on or off the at least one display device **124a-n**, where the requests are generated by operating system **206**. In one particular embodiment, the power one or off request is generated by an input device, such as a mouse or a keyboard.

In another embodiment, the driver **202** is a file system filter driver or a mini-driver. The driver **202** can also be a user mode hooking mechanism. In some embodiments, the driver **202** refers to a hooking mechanism, that accesses one or more software libraries to perform the functionality described herein. The driver can also be a kernel mode hooking mechanism, such as a kernel mode driver.

In some embodiments, driver **202** includes a plurality of drivers. In these embodiments, a first driver **202b** may be provided to intercept requests from the operating system **206**, and a second driver **202c** may be provided to intercept requests originated by the resource **208**. In another of these embodiments, the first driver **202b** executes in kernel mode and the second driver **202c** executes in user mode. Alternatively, first driver **202b** executes in user mode and the second driver **202c** executes in kernel mode. In another of these embodiments, first and second driver **202b**, **202c** each execute in kernel mode. Alternatively, first and second driver **202b**, **202c** each execute in user mode. In another embodiment, driver **202** includes functionality for intercepting requests from either operating system **206** or the resource **208**.

Operating system **206** includes a component, such as a kernel mode component, responsible for transmitting an instruction to the display adapter **204** to power on at least one of the display device **124a-n**. In one particular embodiment, the component is part of a MICROSOFT WINDOWS operating system and may execute as part of the WIN32K.sys component of the operating system.

In accordance with the present disclosure, driver **202** is connected with the local agent **120** and receives a signal indicating that a remote user is interacting with data generated on computing device **106**. In particular, agent **212** of remote computing device **106** communicates with agent **120** to determine whether the remote user is interacting with a remote display of locally generated data. Local agent **120** and remote agent **212** communicate according to a thin-client or remote-display protocol as described hereinabove in connection with FIGS. 1A-1C. In one particular embodiment, remote agent **212** is a server agent transmitting data, generated by resource **208**, to local agent **210** for displaying on at least one display device **124a-n** of local computing device **102**.

Resource **208** executes on local computing device **106** and generates output data. Remote agent **212** receives the generated output data and forwards the generated output data to local agent **120**. Local agent **120** then directs a display of the received output data on the display device of local, computing device **102**. For example, local agent **120** may direct an operating system executing in local computing device **102**, such as, for example, operating system **206**, to display the received output data on at least one display device **124a-n**. Resource **208** may include a program, an application, a document, a file, a plurality of applications, a plurality of files, an executable program, file, a desktop environment, a computing environment, or other resource made available to a user of the computing device **102**. In one of these embodiments, a computing environment may be one or more of an application, a plurality of applications, a desktop application, and a desktop session in which one or more applications may execute. In other embodiments, a resource **208** implements an application-



programming interface (API) such as the MICROSOFT DirectX or the Open Graphics Library (OpenGL) graphics APIs.

With continuing reference to FIG. 2, driver 202 creates a power management system to power down the locally attached display devices (i.e. monitors) when a remote user is connected to local computing device 106. In particular, the local agent 210 activates a filter 202a executing in driver 202, when a remote user is connected. In accordance with the present disclosure, when operating system 206 receives a signal (for example, from an input device) to activate at least one display device, operating system 206 generates and sends a request signal to display adapter 204. Filter 202a intercepts the requests and redirects the request signal to local agent 120 when a remote user is currently active. If the remote user is not currently active, or if the remote session has ended, then filter 202a directs the intercepted request to display adapter 204. However, filter 202a will send a signal to the operating system indicating that the display device has been powered on, even when the intercepted message was redirected to local agent 120. Thus, filter 202a will in effect trick, operating system 206 into believing that the display device is powered on. Therefore, a user local to the local computing device 106 is unable to see what the remote user is doing on the local desktop. Even attempting to plug-in a new monitor, for example, will still fail to display the secure data since display adapter 204 never received the instructions from operating system 206. In one particular embodiment, filter 202a is activated whenever a remote session is established and is inactive when the remote session is terminated. This activating and deactivating is executing by local agent 120.

Referring now to FIG. 3, a flow diagram illustrating one embodiment of a method of filtering a request to display data generated by a remote computing device. The method includes receiving, by a filter executing in a driver, a signal indicating that a remote session has been established with a remote computing device for interacting with data generated by a local computing device (302); generating, by an operating system executing in the local computing device, a request to enable at least one local display device controlled by a display adapter (304); intercepting, by the filter, the request generated by the operating system (306); blocking, by the driver, the request when an a remote user is active (308); and transmitting, by the filter, to the operating system a signal, indicating that the display adapter has enabled the display device (310).

With continued reference to FIG. 3, in conjunction with FIG. 2, driver 202, executing on a computing device 106, intercepts a request generated, by operating system 206, to enable at least one of the display device 124a-n associated with the computing device 106. This request to enable at least one of the display device 124a-n is typically directed to display adapter 204. Filter 202a, which executes in driver 202, monitors the request directed to display adapter 204. In one embodiment, filter 202a of driver 202 intercepts an instruction to display adapter 204 to power on at least one of display device 124a-n. In another embodiment, filter 202a of driver 202 intercepts an instruction transmitted by a component in operating system 206 when the component determines that a user has interacted with a local input/output device, such as a keyboard or mouse. In some embodiments, the driver 202 intercepts input/output requests addressed to the display adapter 204 by monitoring communication received by a video device.

In accordance with the present disclosure, when driver 202 receives an indication that a remote user is interacting with a remote display of locally generated data (302), driver 202

then decides whether to transmit the intercepted request to enable at least one of display device 124a-n to display adapter 204 or to local agent 120. In one embodiment, the driver 202 receives the presence of a remote user from local agent 120 executing on local computing device 106. Agent 120 is in communication with an agent 210 on remote computing device 102 to determine whether the remote user is interacting with the remote display of locally generated data. Driver 202 will also receive an indication that the remote user has terminated interaction with the remote display of the locally generated data. If a user has terminated interaction with the locally generated data or driver 202 does not have indication of a remote session, the filter 202a will transmit, to display adapter 204, the intercepted request to enable the display device 124a. In one particular embodiment, upon receiving the indication that the remote user no longer interacts with the remote display of locally generated data, driver 202 makes a determination to allow the operating system 206 to direct the powering on of the display device 124a without interception by driver 202.

Alternatively, the driver determines not to transmit, the intercepted request to the display adapter based upon the received indication that the remote user is interacting with the remote display. By not transmitting the intercepted request to the display adapter 204, the driver 202 prevents the display adapter 204 from, powering on the display device 124a.

In one embodiment, the driver 202 determines whether the intercepted request is a request to change a power state of the display device 124a from a first power state—such as, for example, off—to a second power state—such as, for example, on. In another embodiment, the driver 202 determines whether the intercepted request includes an identification of a type of the request. In yet another embodiment, the driver 202 determines whether to prevent transmission of the request to the display adapter 204 based upon a type of the request. For example, the driver 202 determines that the request is an “IOCTL\_VIDEO\_SET\_OUTPUT\_DEVICE\_POWER\_STATE” type of request, determines that a remote user is interacting with data generated by the computing device 106, and makes a determination not to forward the request to the display adapter 204.

In another embodiment, the driver 202 determines that a remote user is interacting with data generated by the local computing device 106 and the driver 202 generates an instruction to the display adapter 204 to power down the display device 124a. Thus, upon intercepting a subsequent request from the operating system 206 to power on at least one of the display device 124a-n and confirming that the remote user continue to interact with the generated data, the driver 202 prevents the intercepted request from reaching the display adapter 204 by not forwarding the intercepted request. In other embodiments, the driver 202 determines that the remote user no longer interacts with the locally generated data, for example, by querying local agent 120, and allows the intercepted request to reach the display adapter 204 by forwarding the request.

When local computing device 106 is associated with, a plurality of monitors, the driver 202 intercepts at least one request addressed, to the display adapter 204 to power on each of a plurality of monitors and driver 202 prevents the display adapter 204 from powering on any of the monitors, by not forwarding the intercepted request. This is true even when the plurality of monitors each displays a subset of the output data generated by or received for display by the local computing device 106.

The driver 202 transmits to operating system 206, an indication that the display adapter enabled the display device



(310) regardless of whether or not the intercepted request for forwarded to display adapter 204. By transmitting the indication to the operating system 206 prevents unauthorized display of data to users of the computing device 106 while allowing the operating system. 206 to execute without modification. In one particular embodiment, by responding to the intercepted request with an indication that the display adapter 204 enabled the display device 124a, the driver 202 causes the operating system 206 to operate as if the display device 124a were powered on.

Resource 208 executes substantially differently if a display device 124 is powered on than if the display device 124 is powered off. For example, resource 208 make a determination, to terminate its execution, based upon a determination that at least one of display device 124a-n is disabled. Alternatively, resource 208 restarts execution based upon a determination that the display device 124 is disabled.

In one embodiment, resource 208 requests a status of at least one display device 124a-n and directs a display of output data generated by the resource 208 based, upon the indication that at least one display device 124a-n is enabled. For example, resource 208 may instruct a graphics system provided by the operating system 200 to instruct the display adapter 204 to display the output data on the display device 124a.

In another embodiment, resource 208 directs a display of output data generated by the resource 208, for example, by instructing the graphics system, to display the output data on at least one display device 124a-n. The graphics system instructs display adapter 204 to display the generated output data. If at least one display device 124a is disabled, then display adapter 204 responds to the instruction with an indication that the display failed. Alternatively, if at least one of display device 124a-n is enabled, then display adapter 204 responds to the instruction with an indication that the display succeeded. The graphics system forwards the received response to the resource 208. In one particular embodiment, the resource 208 may terminate or interrupt execution, if the response indicates that the display of output data failed.

In one embodiment, driver 202 intercepts a request, from the resource 208, addressed to display adapter 204, for a status of at least one display device 124a-n. In another embodiment the driver 202 intercepts a request, from the operating system 206 on behalf of the resource 208, for a status of at least one display device 124a-n. In still another embodiment, the driver 202 intercepts a request, from a graphics system executing on the computing device 106 on behalf of the resource 208, for a status of the display device 124a. In some embodiments, the driver 202 intercepts graphics commands in which the resource 208 requests information associated with state of the display device 124a-n.

In one particular embodiment, the intercepted request is a call to a function that provides an indication of a monitor state. For example, the intercepted request is a call to a D3DKMTCheck.MonitorPowerState function or a D3DKMTWaitForVerticalBlankEvent function. Alternatively, the intercepted request is a call to a D3DKMTPresent function. In another embodiment, the intercepted request is a call to a VidSchGetMonitorPowerState function or a VidSchSetMonitorPowerState function.

Driver 202 may, in some embodiments, determine that display device 124a-n is disabled and that the remote user is interacting with a remote display of the locally generated data. In these embodiments, driver 202 transmits, to the resource 208, a response to the intercepted request indicating that the display device is enabled. A second driver (not shown) intercepts the request determines that the display

device 124a is disabled and that the remote user is interacting with a remote display of the locally generated data, and transmits the response to the resource 208. In this particular embodiment, driver 202 is in communication with the second driver. In addition, driver 202 may intercept operating system 206 requests and the second driver may intercept requests from the resource 208.

In one embodiment, the resource 208 generates output data for display substantially in synchronization with a cycle on the display device 124a for refreshing data. For example, the display device 124a-n may refresh a data display periodically and the resource 208 may delay generation of new data for display until the display device 124a begins a new cycle (which may be referred to as a refresh cycle). In addition, the driver 202 intercepts a request for a status of a refresh cycle on the display device 124a. Alternatively, the driver 202 determines that the display device 124a is disabled and not refreshing a display of data or driver 202 responds to the request with an indication that the display device 124a has refreshed a display of data.

Accordingly, by preventing display adapter 204 from powering on a disabled display device 124a-n, driver 202 prevents unauthorized viewing of display data. In addition, by determining that at least one display device 124a-n of a local computing device 106 is disabled during interaction, by a remote user of a local computing device 102, with locally generated output data, and by indicating to the resource 208 generating the output data that the display device 124a-n is enabled, the driver 202 prevents unauthorized viewing of display data and prevents the resource 208 from terminating or interrupting the user interaction with the generated output data.

In some applications,

The systems and methods described above may be provided as one or more computer-readable programs embodied on or in one or more articles of manufacture. The article of manufacture may be a floppy disk, a hard disk, a CD-ROM, a flash memory card, a PROM, a RAM, a ROM, or a magnetic tape. In general, the computer-readable programs may be implemented in any programming language, LISP, PERL, C, C++, PROLOG, or any byte code language such as JAVA. The software programs may be stored on or in one or more articles of manufacture as object code.

While FIGS. 1-3 illustratively describe exemplary components and devices that can be used to practice the exemplary systems and methods, according to specific embodiments, it is clear that a person ordinarily skilled in the art can readily modify the demonstrated computing devices as well as the method steps for adaptation to application requirements consistent with the above descriptions. It should therefore be recognized that the present systems and methods are not limited to the specific embodiments illustrated hereinabove, but rather extends in utility to any other modification, variation, application, and embodiment, and accordingly, all such modifications, variations, applications, and embodiments are to be regarded as being within the scope of the presently described systems and methods.

What is claimed is:

1. A system comprising:

- a local agent executing on a first computing device, the local agent communicating with a remote agent executing on a remote computing device; and
- a driver executing on the first computing device, the driver comprising a filter configured to intercept a request for a display adapter to change a power state of a display device connected to the first computing device and, responsive to the intercepted request: (a) when a user of



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the remote computing device is active, transmit the intercepted request to the local agent, and (b) when the user of the remote computing device is not active, transmit the intercepted request to the display adapter.

2. The system of claim 1, wherein the driver receives an indication that a remote user is interacting with data generated locally to the first computing device. 5

3. The system of claim 1, wherein the local agent is configured to activate the filter when a remote session is facilitated with the remote computing device. 10

4. The system of claim 1, wherein the driver is in communication with the local agent, the display adapter, and an operating system executing on the computing device.

5. The system of claim 4, wherein the filter is further configured to transmit a signal to the operating system that the display adapter has enabled the display device when the filter transmits the intercepted request. 15

6. The system of claim 4, wherein the request is generated by the operating system.

7. The system of claim 1, wherein the driver is a user mode hooking mechanism. 20

8. The system of claim 1, wherein the driver is a kernel mode hooking mechanism.

9. The system of claim 1, wherein the local agent is configured to activate the filter when a remote session is established from the remote computing device and to deactivate the filter when the remote session is terminated. 25

10. A method comprising:

executing a local agent on a first computing device, the local agent communicating with a remote agent executing on a remote computing device; and 30

executing a driver on the first computing device, the driver comprising a filter configured to intercept a request for a

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display adapter to change a power state of a display device connected to the first computing device and, responsive to the intercepted request: (a) when a user of the remote computing device is active, transmit the intercepted request to the local agent, and (b) when the user of the remote computing device is not active, transmit the intercepted request to the display adapter.

11. The method of claim 10, wherein the driver receives an indication that a remote user is interacting with data generated locally to the first computing device.

12. The method of claim 10, wherein the local agent is configured to activate the filter when a remote session is facilitated with the remote computing device.

13. The method of claim 10, wherein the driver is in communication with the local agent, the display adapter, and an operating system executing on the computing device.

14. The method of claim 13, wherein the filter is further configured to transmit a signal to the operating system that the display adapter has enabled the display device when the filter transmits the intercepted request.

15. The method of claim 13, wherein the request is generated by the operating system.

16. The method of claim 10, wherein the driver is a user mode hooking mechanism.

17. The method of claim 10, wherein the driver is a kernel mode hooking mechanism.

18. The method of claim 10, wherein the local agent is configured to activate the filter when a remote session is established from the remote computing device and to deactivate the filter when the remote session is terminated.

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